



Indiana’s academic standards for Environmental Science, Advanced contain two standards, The Principles of Environmental Science and Historical Perspectives of Environmental Science. Ideas listed underneath each standard build the framework for an Environmental Science, Advanced course.

In addition, ideas from the following four supporting themes will enable students to understand that science, mathematics, and technology are interdependent human enterprises, and that scientific knowledge and scientific thinking serve both individual and community purposes.

The Nature of Science and Technology

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the other. This first theme draws portraits of science and technology that emphasize their roles in the scientific endeavor and reveal some of the similarities and connections between them. In order for students to truly understand the nature of science and technology, they must model the process of scientific investigation through inquiries, fieldwork, lab work, etc. Through these experiences, students will practice designing investigations and experiments, making observations, and formulating theories based on evidence.

Scientific Thinking

There are certain thinking skills associated with science, mathematics, and technology that young people need to develop during their school years. These are mostly, but not exclusively, mathematical and logical skills that are essential tools for both formal and informal learning and for a lifetime of participation in society as a whole. Good communication is also essential in order to both receive and disseminate information and to understand others’ ideas as well as have one’s own ideas understood. Writing, in the form of journals, essays, lab reports, procedural summaries, etc., should be an integral component of students’ experiences in Environmental Science, Advanced.

The Mathematical World

Mathematics is essentially a process of thinking that involves building and applying abstract, logically connected networks of ideas. These ideas often arise from the need to solve problems in science, technology, and everyday life – problems ranging from how to model certain aspects of a complex scientific problem to how to balance a checkbook. Students should apply mathematics in scientific contexts and understand that mathematics is a tool used in science to help solve problems, make decisions, and understand the world around them.

Common Themes

Some important themes, such as systems, models, constancy, and change, pervade science, mathematics, and technology and appear over and over again, whether we are looking at ancient civilization, the human body, or a comet. These ideas transcend disciplinary boundaries and prove fruitful in explanation, in theory, in observation, and in design. These themes provide students with opportunities to engage in long-term and on-going laboratory and fieldwork and to understand the role of change over time in studying concepts in Environmental Science, Advanced.



Principles of Environmental Science

Students investigate, through laboratory and fieldwork, the concepts of environmental systems, populations, natural resources, and environmental hazards.

Environmental Systems

- Env.1.1 Know and describe how ecosystems can be reasonably stable over hundreds or thousands of years. Consider as an example the ecosystem of the Great Plains prior to the advent of the horse in Native American Plains societies, from then until the advent of agriculture, and well into the present.
- Env.1.2 Understand and describe that if a disaster occurs — such as flood or fire — the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.
- Env.1.3 Understand and explain that ecosystems have cyclic fluctuations, such as seasonal changes or changes in population, as a result of migrations.
- Env.1.4 Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems.
- Env.1.5 Explain how the size and rate of growth of the human population in any location is affected by economic, political, religious, technological, and environmental factors, some of which are influenced by the size and rate of growth of the population.
- Env.1.6 Describe and give examples about how the decisions of one generation both provide and limit the range of possibilities open to the next generation.
- Env.1.7 Recognize and explain that in evolutionary change, the present arises from the materials of the past and in ways that can be explained, such as the formation of soil from rocks and dead organic matter.
- Env.1.8 Recognize and describe the difference between systems in equilibrium and systems in disequilibrium.
- Env.1.9 Diagram the cycling of carbon, nitrogen, phosphorus, and water.
- Env.1.10 Identify and measure biological, chemical, and physical factors within an ecosystem.
- Env.1.11 Locate, identify, and explain the role of the major Earth biomes and discuss how the abiotic and biotic factors interact within these ecosystems.
- Env.1.12 Explain the process of succession, both primary and secondary, in terrestrial and aquatic ecosystems.

Flow of Matter and Energy

- Env.1.13 Understand and describe how layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. Recognize that by burning these fossil fuels, people are passing stored energy back into the environment as heat and releasing large amounts of carbon dioxide.
- Env.1.14 Recognize and explain that the amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle organic materials from the remains of dead organisms.
- Env.1.15 Describe how the chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways.



- Env.1.16 Cite examples of how all fuels have advantages and disadvantages that society must question when considering the trade-offs among them, such as how energy use contributes to the rising standard of living in the industrially developing nations. However, explain that this energy use also leads to more rapid depletion of Earth's energy resources and to environmental risks associated with the use of fossil and nuclear fuels.
- Env.1.17 Describe how decisions to slow the depletion of energy sources through efficient technology can be made at many levels, from personal to national, and they always involve trade-offs of economic costs and social values.
- Env.1.18 Illustrate the flow of energy through various trophic levels of food chains and food webs within an ecosystem. Describe how each link in a food web stores some energy in newly made structures and how much of the energy is dissipated into the environment as heat. Understand that a continual input of energy from sunlight is needed to keep the process going.

Populations

- Env.1.19 Demonstrate and explain how factors such as birth rate, death rate, and migration rate determine growth rates of populations.
- Env.1.20 Demonstrate how resources, such as food supply, influence populations.

Natural Resources

- Env.1.21 Differentiate between renewable and nonrenewable resources, and compare and contrast the pros and cons of using nonrenewable resources.
- Env.1.22 Demonstrate a knowledge of the distribution of natural resources in the U.S. and the world, and explain how natural resources influence relationships among nations.
- Env.1.23 Recognize and describe the role of natural resources in providing the raw materials for an industrial society.
- Env.1.24 Give examples of the various forms and uses of fossil fuels and nuclear energy in our society.
- Env.1.25 Recognize and describe alternative sources of energy provided by water, the atmosphere, and the sun.
- Env.1.26 Identify specific tools and technologies used to adapt and alter environments and natural resources in order to meet human physical and cultural needs.
- Env.1.27 Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit.
- Env.1.28 Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources.
- Env.1.29 Recognize and describe important environmental legislation, such as the Clean Air Act and the Clean Water Act.



Environmental Hazards

- Env.1.30 Describe how agricultural technology requires trade-offs between increased production and environmental harm and between efficient production and social values.
- Env.1.31 Understand and explain that waste management includes considerations of quantity, safety, degradability, and cost. Also understand that waste management requires social and technological innovations because waste-disposal problems are political and economic as well as technical.
- Env.1.32 Understand and describe how nuclear reactions release energy without the combustion products of burning fuels, but that the radioactivity of fuels and by-products poses other risks which may last for thousands of years.
- Env.1.33 Identify natural Earth hazards, such as earthquakes and hurricanes, and identify the regions in which they occur as well as the short-term and long-term effects on the environment and on people.
- Env.1.34 Differentiate between natural pollution and pollution caused by humans and give examples of each.
- Env.1.35 Compare and contrast the beneficial and harmful effects of an environmental stressor, such as herbicides and pesticides, on plants and animals. Give examples of secondary effects on other environmental components.

Standard 2

Historical Perspectives of Environmental Science

Students gain understanding of how the scientific enterprise operates through examples of historical events. Through the study of these events, they understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators.

- Env.2.1 Explain that Rachael Carson's book, *Silent Spring*, explained how pesticides were causing serious pollution and killing many organisms. Understand that it was the first time anyone had publicly shown how poisons affect anything in nature. Note in particular that the book detailed how the pesticide DDT had gotten into the food chain. Understand that as a result of *Silent Spring*, there are now hundreds of national, state, and local laws that regulate pesticides.
- Env.2.2 Explain that Henry Cowles found the Indiana Dunes and Lake Michigan shoreline area a natural laboratory for developing important principles of plant succession.